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YANG et al.(10) **Pub. No.: US 2007/0290984 A1**(43) **Pub. Date: Dec. 20, 2007**(54) **LIQUID CRYSTAL DISPLAY AND CONTROL METHOD OF THE SAME**(30) **Foreign Application Priority Data**

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G09G 3/36 (2006.01)(52) **U.S. Cl.** **345/101**(57) **ABSTRACT**

A liquid crystal display including a liquid crystal panel, a temperature sensor sensing a temperature of the liquid crystal panel, a gray scale voltage generating part including a plurality of gray scale voltage generating units each generating a first gray scale voltage set corresponding to a preset temperature and a controller generating a second gray scale voltage set corresponding to the sensed temperature using the first gray scale voltage sets when the sensed temperature does not correspond to the preset temperature.

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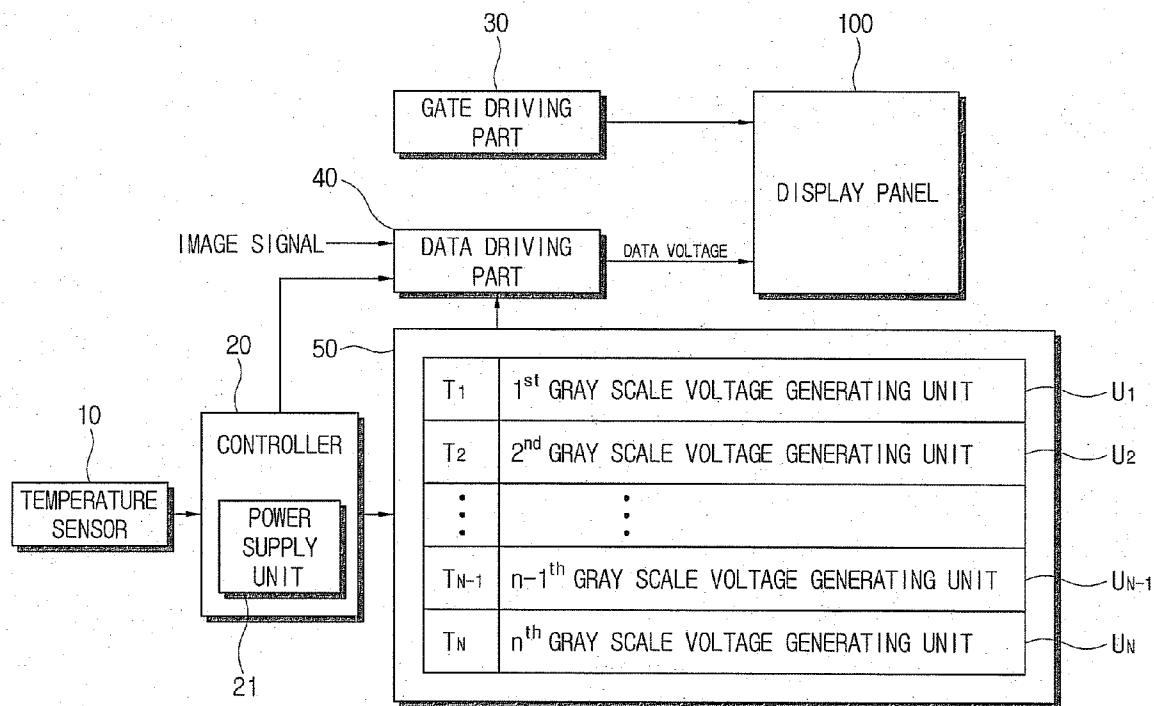
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FIG. 1

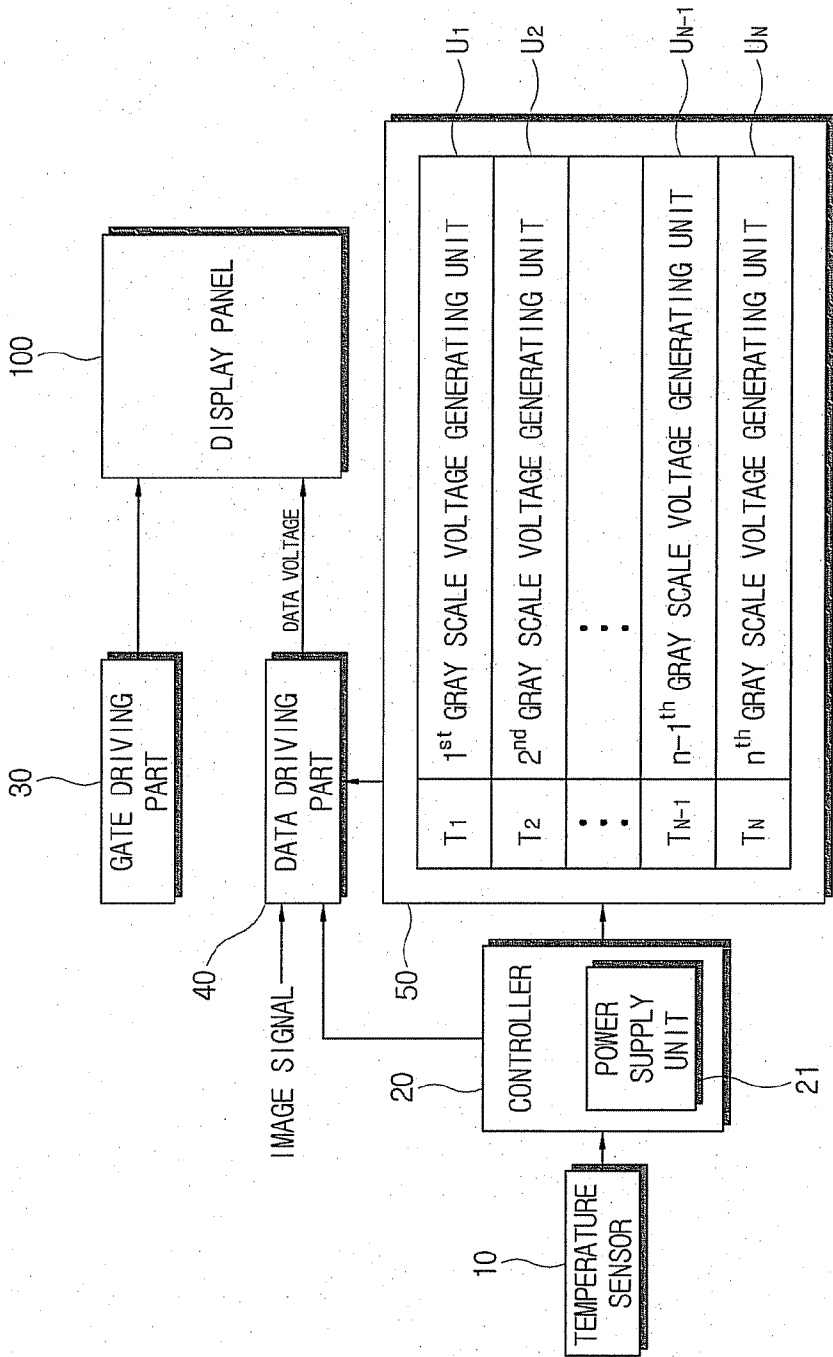


FIG. 2

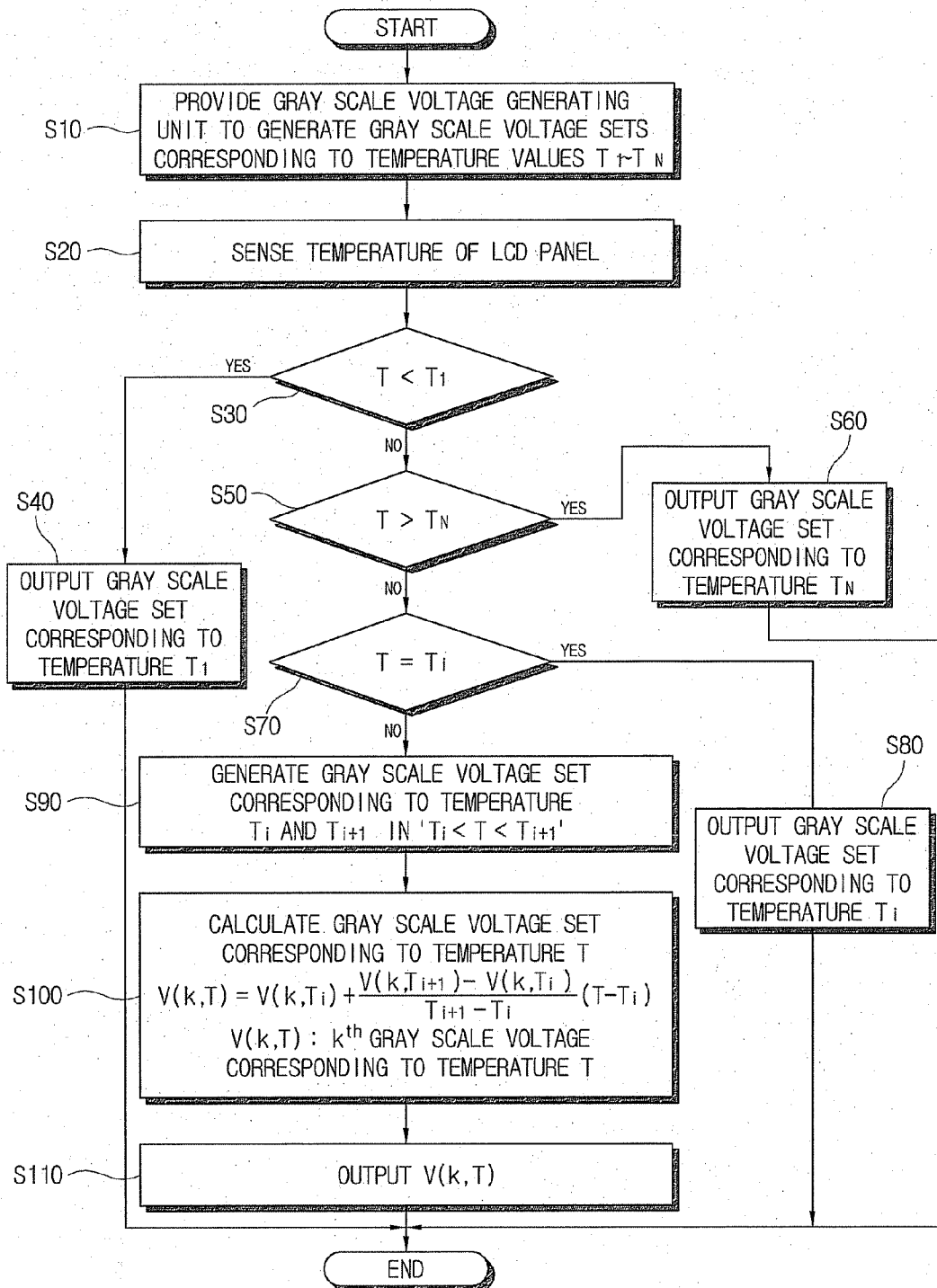


FIG. 3

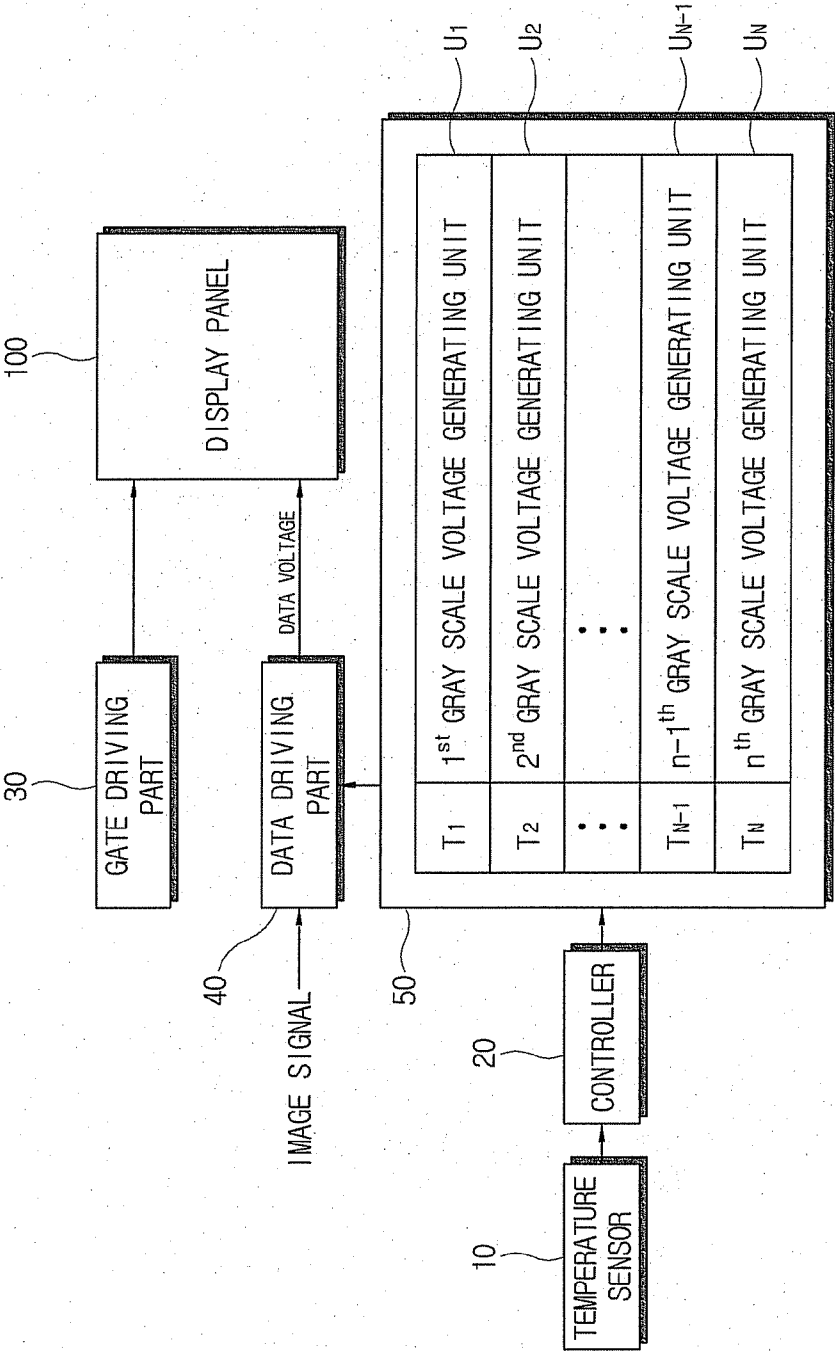
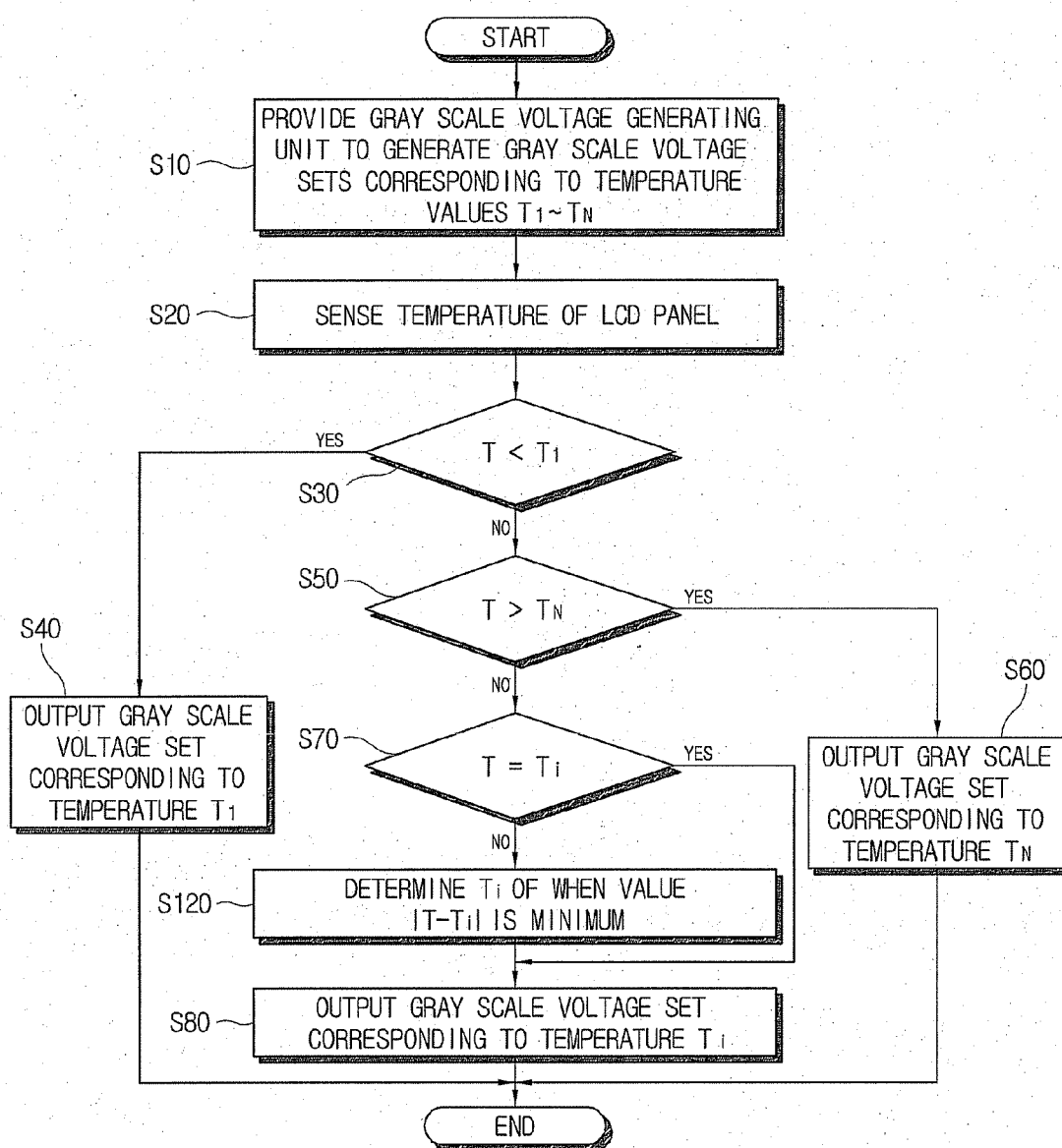


FIG. 4



LIQUID CRYSTAL DISPLAY AND CONTROL METHOD OF THE SAME

[0001] This application claims priority to Korean Patent Application No. 2006-0046645, filed on May 24, 2006 and all the benefits accruing therefrom under 35 U.S.C. §119, the contents of which are herein incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display and a control method of the same, and more particularly, to a liquid crystal display which generates a plurality of gray-scale voltages and a control method of the same.

[0004] 2. Description of the Related Art

[0005] A liquid crystal display ("LCD") includes an LCD panel having a thin film transistor ("TFT") substrate where TFTs are formed, a color filter substrate where color filter layers are formed, and a liquid crystal layer disposed between two substrates.

[0006] An arrangement of liquid crystal molecules in the liquid crystal layer varies depending on voltage applied to the TFTs, by which transmittance of light is affected. In other words, the LCD displays desired images, with the liquid crystal molecules arranged where the transmittance of light is adjusted.

[0007] The liquid crystal molecules have different characteristics according to temperature. Particularly, dielectric anisotropy ($\Delta\epsilon$), modulus of elasticity (k) and refractive index anisotropy (Δn) of the liquid crystal molecules drastically vary at critical temperatures where characteristics of the liquid crystal molecules vary. Variation of the liquid crystal molecules affects the transmittance of light, and accordingly the images may not be displayed on a display panel normally.

[0008] Thus, it is necessary to generate gray scale voltages different according to temperature of the liquid crystal molecules and transmittance owing to the temperature.

BRIEF SUMMARY OF THE INVENTION

[0009] An exemplary embodiment provides an LCD and a control method thereof, generating a suitable gray scale voltage for temperature.

[0010] An exemplary embodiment provides a liquid crystal display including a liquid crystal panel, a temperature sensor sensing a temperature T of the liquid crystal panel, a gray scale voltage generating part including a plurality of gray scale voltage generating units each generating a first gray scale voltage set corresponding to a preset temperature and a controller generating a second gray scale voltage set corresponding to the sensed temperature T using the first gray scale voltage sets when the sensed temperature T does not correspond to the preset temperature.

[0011] In an exemplary embodiment, the gray scale voltage generating part further includes an N number of the gray scale voltage generating units corresponding to a first temperature T_1 through an N -th temperature T_N , respectively, and each of the first gray scale voltage sets include a plurality of gray scale voltages. When a temperature T_i is in a range between the first temperature T_1 and the N -th

temperature T_N , and the sensed temperature T satisfies $T_i < T < T_{i+1}$, the controller calculates a k -th gray scale voltage $V(k, T)$ corresponding to the temperature T by the following equation:

$$V(k, T) = V(k, T_i) + \frac{V(k, T_{i+1}) - V(k, T_i)}{T_{i+1} - T_i} (T - T_i)$$

[0012] where $V(k, T_{i+1})$ is a k -th gray scale voltage corresponding to the temperature T_{i+1} and $V(k, T_i)$ is a k -th gray scale voltage corresponding to the temperature T_i .

[0013] In an exemplary embodiment, the controller outputs the second gray scale voltage set corresponding to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

[0014] In an exemplary embodiment, the controller outputs the second gray scale voltage set corresponding to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

[0015] In an exemplary embodiment, the gray scale voltage generating units each include a variable resistor logic part used to generate the first gray scale voltage sets.

[0016] In an exemplary embodiment, the liquid crystal display further includes a data driving part generating a data voltage base on the second gray scale voltage set. The controller outputs the second gray scale voltage set corresponding to the sensed temperature T to the data driving part.

[0017] An exemplary embodiment provides a liquid crystal display including a liquid crystal panel, a temperature sensor sensing a temperature T of the liquid crystal panel, a gray scale voltage generating part including a plurality of gray scale voltage generating units each generating a gray scale voltage set corresponding to a preset temperature and a controller controlling the gray scale voltage generating part and generating the gray scale voltage set corresponding to the preset temperature which has minimum difference from the sensed temperature T when the sensed temperature does not correspond to the preset temperature.

[0018] In an exemplary embodiment, the gray scale voltage generating units each include a variable resistor logic part used to generate a plurality of gray scale voltages.

[0019] In an exemplary embodiment, the gray scale voltage generating part further includes an N number of the gray scale voltage generating units corresponding to a temperature T_1 through a temperature T_N , respectively, and the controller controls the gray scale voltage generating part and outputs the gray scale voltage set corresponding to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

[0020] In an exemplary embodiment, the controller controls the gray scale voltage generating part and outputs the gray scale voltage set corresponding to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

[0021] An exemplary embodiment provides a control method of a liquid crystal display. The control method includes generating first gray voltage sets corresponding to a first temperature T_1 through an N -th temperature T_N , respectively, sensing a temperature T of the liquid crystal panel and generating a second gray scale voltage set corresponding to the sensed temperature T using the first gray

scale voltage sets when the sensed temperature T is not between the first temperature T_1 and the N -th temperature T_N .

[0022] In an exemplary embodiment, the generating first gray scale voltage sets includes generating a plurality of gray scale voltages. The generating a second gray scale voltage set includes when a temperature T_i is in a range between the first temperature T_1 and the N -th temperature T_N and the sensed temperature T satisfies $T_i < T < T_{i+1}$, calculating a k -th gray scale voltage $V(k, T)$ corresponding to the temperature T by the following equation:

$$V(k, t) = V(k, T_i) + \frac{V(k, T_{i+1}) - V(k, T_i)}{T_{i+1} - T_i}(T - T_i)$$

[0023] where $V(k, T_{i+1})$ is a k -th gray scale voltage corresponding to the temperature T_{i+1} and $V(k, T_i)$ is a k -th gray scale voltage corresponding to the temperature T_i .

[0024] In an exemplary embodiment, the generating a second gray scale voltage set further includes generating a third gray scale voltage set corresponding to the temperature T_i and a fourth gray scale voltage set corresponding to the temperature T_{i+1} .

[0025] In an exemplary embodiment the second gray scale voltage set corresponds to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

[0026] In an exemplary embodiment, the second gray scale voltage set corresponds to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

[0027] An exemplary embodiment provides a control method of a liquid crystal display. The control method includes generating gray voltage sets corresponding to a first temperature T_1 through an N -th temperature T_N , respectively, sensing a temperature T of the liquid crystal panel and selecting the gray scale voltage set corresponding to a temperature between the first temperature T_1 and the N -th temperature T_N which has minimum difference from the sensed temperature T when the sensed temperature is higher than the first temperature T_1 or lower than the N -th temperature T_N .

[0028] In an exemplary embodiment the selected gray scale voltage set corresponds to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

[0029] In an exemplary embodiment the selected gray scale voltage set corresponds to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The above and/or other aspects and advantages of the present invention will become apparent and more readily appreciated from the following description of the exemplary embodiments, taken in conjunction with the accompanying drawings of which:

[0031] FIG. 1 is a control block diagram of a liquid crystal display according to a first exemplary embodiment of the present invention;

[0032] FIG. 2 is a control flow chart to illustrate a control method of the liquid crystal display according to the first exemplary embodiment of the present invention;

[0033] FIG. 3 is a control flow chart to illustrate a control method of a liquid crystal display according to a second exemplary embodiment of the present invention; and

[0034] FIG. 4 is a control flow chart to illustrate a control method of the liquid crystal display according to the second exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0035] Reference will now be made in detail to exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0036] The invention is described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the size and relative sizes of layers and regions may be exaggerated for clarity.

[0037] It will be understood that when an element or layer is referred to as being "connected to" another element or layer, the element or layer can be directly coupled to another element or layer or intervening elements or layers. In contrast, when an element is referred to as being "directly coupled to" another element or layer, there are no intervening elements or layers present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0038] It will be understood that, although the terms first, second, third, etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0039] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0040] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0041] All methods described herein can be performed in a suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., “such as”), is intended merely to better illustrate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention as used herein.

[0042] Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

[0043] Referring to FIG. 1, an LCD according to a first exemplary embodiment includes a temperature sensor **10**, an LCD panel **100**, a gate driving part **30** and a data driving part **40** generating a driving voltage applied to the LCD panel **100**, a gray scale voltage generating part **50** including a plurality of gray scale voltage generating units U_1 through U_N ; and a controller **20** controlling the plurality of gray scale voltage generating units U_1 through U_N . The controller **20** includes a power supply unit **21**.

[0044] In the first embodiment, the LCD panel **100** includes a TFT substrate where a plurality of pixels are formed, a color filter substrate where color filters are formed and a liquid crystal layer disposed therebetween.

[0045] The TFT substrate includes a plurality of pixels which are defined by a plurality of data lines and gate lines (not shown). Each pixel includes a switching element (Q) which is connected to the gate line and the data line, and a liquid crystal capacitor (C_{lc}) and a storage capacitor (C_{st}) which are connected to the switching element. The plurality of gate lines extends in a row direction and transmit a gate voltage corresponding to a scanning signal or a gate signal. The plurality of data lines extend in a column direction and transmit a data voltage corresponding to an image signal. The switching element (Q) may include three terminals such as a control terminal connected to a gate line, an input terminal connected to a data line and an output terminal connected to the liquid crystal capacitor (C_{lc}) and the storage capacitor (C_{st}).

[0046] In the LCD panel **100** with the aforementioned structure, when a gate on voltage is applied to the gate line so that the switching element (Q) is on, a data voltage provided to the data line is applied to a pixel electrode through the switching element (Q). Then, an electric field due to a difference between a pixel voltage applied to the pixel electrode and a common voltage is formed in the liquid crystal layer, and light passes through the liquid crystal layer having variable transmittance depending on the electric field.

[0047] The temperature sensor **10** senses the temperature of the LCD panel **100**. In the illustrated embodiment, an optimal gray scale voltage is formed to correspond to a variation of liquid crystal molecules according to temperature variation. In one exemplary embodiment, is preferable to sense the temperature of the liquid crystal layer in the LCD panel **100**.

[0048] The controller **20** selects a gray scale voltage set or creates a new gray scale voltage set using the power supply unit **21**. The power supply unit **20** creates the new gray scale voltage set using a preset gray scale voltage established on the basis of the sensed temperature.

[0049] The gray scale voltage generating part **50** includes a plurality of gray scale voltage generating units U_1 through U_N . The gray scale voltage generating part **50** generates a

plurality of gray scale voltage sets using the gray scale voltage generating units U_1 through U_N . The gray scale voltage generating units U_1 through U_N generate different gray scale voltage sets depending on different temperatures T_1 through T_N . The gray scale voltage is a reference voltage of an ultimate data voltage to the LCD panel **100** to display gradations. As the liquid crystal molecules are aligned variably depending on voltage, the reference voltage is necessary to linearly adjust the alignment of the liquid crystal molecules. The gray scale voltage functions as the reference voltage to realize images and has a plurality of levels to display images, such as from black to white.

[0050] Since the transmittance of the liquid crystal molecules according to voltage are variable on dielectric anisotropy ($\Delta\epsilon$), modulus of elasticity (k) and refractive index anisotropy (Δn), it is necessary to adjust the voltage applied to the liquid crystal molecules depending on surroundings of the liquid crystal molecules. As the dielectric anisotropy and the refractive index anisotropy decrease around a certain relatively high temperature where the liquid-crystal characteristics disappear, the liquid crystal molecules are remarkably relatively slowly aligned by an electric field, thereby reducing brightness.

[0051] In the illustrated embodiment of the LCD, the gray scale voltage is variably output to the data driving part **40** according to the temperatures of the LCD panel **100**, thereby realizing substantially uniform brightness.

[0052] The “gray scale voltage set” as used herein, means a gray scale voltage group corresponding to one temperature value. That is, the gray scale voltage group corresponding to one temperature value includes a plurality of gray scale voltages. The LCD of the illustrated embodiment includes a plurality of gray scale voltage sets. As used herein, corresponding may be defined as being equal to or being substantially equal (e.g., about or approximately equal).

[0053] The gray scale voltage generating part **50** includes a total of N gray scale voltage generating units U_1 through U_N . In one exemplary embodiment, the gray scale voltage generating units U_1 may be from a first gray scale voltage generating unit U_1 corresponding to a first temperature value T_1 to an N-th gray scale voltage generating unit U_N corresponding to an N-th temperature value T_N . The gray scale voltage generating units U_1 through U_N generates gray scale voltage sets different from one another according to a control of the controller **20**.

[0054] In exemplary embodiments, the first temperature value T_1 through the N-th temperature value T_N may be a specific temperature value or within a predetermined range. Alternatively, the first temperature value T_1 through the N-th temperature value T_N may be set with various values or ranges from a user, and accordingly the gray scale voltage sets may be variable.

[0055] When each of the first temperature value T_1 through the N-th temperature value T_N corresponds to a predetermined temperature range without a gap, for example, 0° C. to 5° C., 5° C. to 10° C. and so on, the controller **20** may select one of the gray scale voltage generating units U_1 through U_N having a temperature range corresponding to the sensed temperature. In this case, the power supply unit **21** of the controller **20** can be omitted.

[0056] In an exemplary embodiment, each of the gray scale voltage generating units U_1 through U_N may include a variable resistor logic part (not shown) to generate the gray scale voltage set having the plurality of gray scale voltages.

The variable resistor logic part may not use a resistor string, but instead may use a transistor logic embedded in a chip to change resistance. In one exemplary embodiment, the logic is programmed to output a resistance value according to a control signal received from the outside and to distribute and output a reference voltage according to the resistance value. Alternatively, the gray scale generating unit may include a plurality of resistor strings and/or the variable resistor logic part.

[0057] The controller **20** controls the gray scale generating units U_1 through U_N to generate an optimal gray scale voltage set to the data driving part **40** according to the temperature of the LCD panel **100**. The controller **20** selects one of the gray scale voltage generating units U_1 through U_N according to the temperature of the LCD panel **10** and controls the selected gray scale voltage generating unit U_X to generate a single gray scale voltage set. Further, the controller **20** may perform various calculations to output individual gray scale voltages directly to the data driving part **40**.

[0058] The gate driving part **30** may be referred to as a scan driving part. The gate driving part **30** is connected to the gate line of the LCD panel **100** and applies a gate signal made of a combination of a gate on voltage (V_{on}) and a gate off voltage (V_{off}) to the gate line.

[0059] The data driving part **40** may be referred to as a source driving part. The data driving part **40** generates a plurality of voltages to display different gradations using a gray scale voltage generated in the gray scale voltage generating part **50**. The plurality of voltages from the data driving part **40** is selected according to an image signal and applied to the data line of the LCD panel **100** as an ultimate data voltage. In one exemplary embodiment, where a digital operation bit of the data driving part **40** is given as '6,' when ten gray scale voltages are applied to the data driving part **40**, the data driving part **40** generates different voltages of sixty four (i.e. 2^6), and selectively outputs the different voltages.

[0060] FIG. 2 is a control flow chart illustrating a control method of the LCD according to the first exemplary embodiment of the present invention.

[0061] The LCD panel **100** and an N number of gray scale voltage generating units U_1 through U_N to generate the gray scale voltage sets corresponding to the temperature values of the first temperature value T_1 to the N-th temperature value T_N , are provided (S10). The first temperature value T_1 denotes a minimum temperature, and the N-th temperature value T_N denotes a maximum temperature. Hereinafter, one of the first temperature value T_1 to the N-th temperature value T_N denotes a temperature T_i .

[0062] An alignment of the liquid crystal molecules substantially changes relative to voltage according to temperature. Accordingly, images may deteriorate and brightness may be variable on the LCD panel **100**. A critical voltage can change the characteristic of the liquid crystal molecules. A critical temperature is where the characteristics of the liquid crystal molecules significantly drastically vary. When voltage values become lower than the critical voltage at the critical temperature, originally white images may be displayed at these lower voltage values as black images. This displaying of black images causes the characteristics of the gray scale voltage to vary and a contrast ratio to deteriorate.

Further, maximum transmittance decreases at a relatively high temperature, and thus the contrast ratio may significantly deteriorate.

[0063] In the illustrated embodiment, the gray scale voltage generating units U_1 through U_N generate gray scale voltages considering a state of the liquid crystal molecules as indicated by a temperature. The gray scale voltage generating units U_1 through U_N generate gray scale voltages under control of the controller **20** and include the variable resistor logic parts to generate the gray scale voltages.

[0064] The temperature T of the LCD panel **100** is sensed by the temperature sensor **10** (S20).

[0065] A determination is made if the temperature T of the LCD panel **100** is lower than the minimum temperature T_1 (S30). If the temperature T is less than the minimum temperature T_1 , the controller **20** controls the first gray scale voltage generating unit U_1 to generate a gray scale voltage set corresponding to the minimum temperature T_1 and outputs the generated gray scale voltage set to the data driving part **40** (S40). In an exemplary embodiment, all ranges of the temperature can be considered to generate an optimal gray scale voltage, but it may not be easily realized. As in the illustrated embodiment, in the operation S30, a determination is made when the LCD may be exposed out of the preset temperature range (e.g., as including the minimum temperature T_1).

[0066] If the sensed temperature T is not lower than the minimum temperature T_1 , the controller **20** determines whether the sensed temperature T is higher than the maximum temperature T_N (S50). The sensed temperature T is compared with the maximum temperature T_N for a same reason as described above with respect to the minimum temperature comparison. In an exemplary embodiment, all ranges of the temperature can be considered to generate an optimal gray scale voltage, but it may not be easily realized. As in the illustrated embodiment, in the operation S50, a determination is made when the LCD may be exposed out of the preset temperature range (e.g., as including the maximum temperature T_N).

[0067] At operation S50, if the sensed temperature T is higher than the maximum temperature T_N , the controller **20** controls the N-th gray scale voltage generating unit U_N to generate a gray scale voltage set corresponding to the maximum temperature T_N and outputs the gray scale voltage set to the data driving part **40** (S60).

[0068] When the sensed temperature T is within a range between the minimum temperature T_1 and the maximum temperature T_N , the controller **20** determines whether the temperature T_i , equal to the sensed temperature T, is found within the range between the minimum temperature T_1 and the maximum temperature T_N . (S70)

[0069] If the temperature T_i as equal to the sensed temperature T, is found within the range, the controller **20** selects a gray scale voltage generating unit U_i corresponding to the temperature T_i to generate a correspondent gray scale voltage set. Then, the controller **20** outputs the gray scale voltage set to the data driving part **40** (S80).

[0070] Alternatively, if the temperature T_i , as equal to the sensed temperature T, is not found within the range, the controller **20** detects the temperature T_i and the temperature T_{i+1} to correspond to ' $T_i < T < T_{i+1}$ ' and generates gray scale voltage sets corresponding to the temperatures T_i and T_{i+1} (S90). In operation S90, the controller **20** prepares basic data to calculate an ultimate gray scale voltage set for the LCD

panel **100**. The gray scale voltage sets corresponding to the temperatures T_i and T_{i+1} may be generated in the gray scale voltage generating units U_i and U_{i+1} immediately or may have been stored already.

[0071] In the illustrated embodiment, the controller **20** calculates a k-th gray scale voltage $V(k, T)$ corresponding to the temperature T using a k-th gray scale voltage $V(k, T_i)$ corresponding to the temperature T_i and a k-th gray scale voltage $V(k, T_{i+1})$ corresponding to the temperature T_{i+1} , and then finally generates a gray scale voltage set corresponding to the temperature T_i . The following equation is used to generate a gray scale voltage set, by which the k-th gray scale voltage $V(k, T)$ corresponding to the temperature T is calculated (S100).

$$V(k, T) = V(k, T_i) + \frac{V(k, T_{i+1}) - V(k, T_i)}{T_{i+1} - T_i}(T - T_i) \quad [\text{Equation 1}]$$

[0072] Equation 1 is given to calculate the optimal gray scale voltage suitable for the temperature T as an example, and various equations and methods may be adopted for the controller **20** to calculate an optimal gray scale voltage.

[0073] The power supply unit **21** generates new gray scale voltage set based on the calculation result and outputs the new gray scale voltage set for the temperature T at operation S100 to the data driving part **40** (Silo).

[0074] In an alternative exemplary embodiment, it may be determined whether the sensed temperature T of the LCD panel **100** is within the range between the temperatures T_1 and T_N before it is determined whether the sensed temperature T is lower than the first temperature T_1 or higher than the N-th temperature T_N because the temperature of the LCD panel **100** is often within the range of the temperatures T_1 through T_i . Thus, to relatively quickly and efficiently generate the gray scale voltage set, the determination of which range includes the sensed temperature T can be changed.

[0075] FIG. 3 is a control flow chart to illustrate a control method of a liquid crystal display according to a second exemplary embodiment of the present invention and FIG. 4 is a control flow chart illustrating another exemplary embodiment of a control method of an LCD according to the present invention.

[0076] A controller **20** does not have a power supply unit and does not calculate an ultimate gray scale voltage set to be output using gray scale voltages generated in the gray scale voltage generating units U_1 through U_N as described above, but selects one of gray scale voltage generating units U_1 through U_N .

[0077] An N number of gray scale voltage generating units U_1 through U_N are provided to generate gray scale voltage sets corresponding to temperature values of a first temperature value T_1 to an N-th temperature value T_N (S10).

[0078] The temperature of an LCD panel **100** is sensed (S20). A determination is made whether the temperature T of the LCD panel **100** is lower than the minimum temperature T_1 (S30). If the temperature T is lower than the minimum temperature T_1 , the controller **20** controls the first gray scale voltage generating unit U_1 to generate a gray scale voltage set corresponding to the minimum temperature T_1 and outputs the gray scale voltage set to the data driving part **40** (S40).

[0079] If the sensed temperature T is not lower than the minimum temperature T_1 , the controller **20** determines whether the sensed temperature T is higher than the maximum temperature T_N (S50).

[0080] If the temperature T is higher than the maximum temperature T_N , the controller **20** controls the N-th gray scale voltage generating unit U_N to generate a gray scale voltage set corresponding to the maximum temperature T_N and outputs the gray scale voltage set to the data driving part **40** (S60).

[0081] When the sensed temperature T is within a range between the minimum temperature T_1 and the maximum temperature T_N , the controller **20** determines whether the temperature T_i equal to the temperature T is found within the range between the minimum temperature T_1 and the maximum temperature T_N (S70).

[0082] If the temperature T_i , as equal to the temperature T , is found within the range between the minimum temperature T_1 and the maximum temperature T_N , the controller **20** selects a gray scale voltage generating unit U_i corresponding to the temperature T_i to generate a correspondent gray scale voltage set. Then, the controller **20** outputs the gray scale voltage set to the data driving part **40** (S80).

[0083] Alternatively, if the temperature T_i , as equal to the temperature T , is not found within the range, the controller **20** determines T_i of when a value of $|T - T_i|$ (e.g., an absolute value of the difference between the sensed temperature T and T_i) is minimum (S120), and outputs a gray scale voltage set corresponding to the temperature T_i to the data driving part **40** (S80).

[0084] In the illustrated embodiments, the LCD has a relatively less complicated control flow than other LCD's and may generate a gray scale voltage set with a simplified method.

[0085] The illustrated embodiments, provide an LCD which generates a suitable gray scale voltage for temperature and a control method of the same.

[0086] Although a few embodiments of the present invention have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims and their equivalents.

What is claimed is:

1. A liquid crystal display comprising:

a liquid crystal panel;

a temperature sensor sensing a temperature T of the liquid crystal panel;

a gray scale voltage generating part comprising a plurality of gray scale voltage generating units each generating a first gray scale voltage set corresponding to a preset temperature; and

a controller generating a second gray scale voltage set corresponding to the sensed temperature T using the first gray scale voltage sets when the sensed temperature T does not correspond to the preset temperature.

2. The liquid crystal display according to claim 1, wherein the gray scale voltage generating part further comprises an N number of the gray scale voltage generating units corresponding to a first temperature T_1 through an N-th temperature T_N , respectively, and each of the first gray scale voltage sets comprises a plurality of gray scale voltages, and

wherein when a temperature T_i is in a range between the first temperature T_1 and the N-th temperature T_N and

the sensed temperature T satisfies $T_i < T < T_{i+1}$, the controller calculates a k -th gray scale voltage $V(k, T)$ corresponding to the temperature T by the following equation:

$$V(k, T) = V(k, T_i) + \frac{V(k, T_{i+1}) - V(k, T_i)}{T_{i+1} - T_i} (T - T_i)$$

where $V(k, T_{i+1})$ is a k -th gray scale voltage corresponding to the temperature T_{i+1} and $V(k, T_i)$ is a k -th gray scale voltage corresponding to the temperature T_i .

3. The liquid crystal display according to claim 1, wherein the gray scale voltage generating part further comprises an N number of the gray scale voltage generating units corresponding to a first temperature T_1 through an N -th temperature T_N , respectively, and each of the first gray scale voltage sets comprises a plurality of gray scale voltages, and the controller outputs the second gray scale voltage set corresponding to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

4. The liquid crystal display according to claim 1, wherein the gray scale voltage generating part further comprises an N number of the gray scale voltage generating units corresponding to a first temperature T_1 through an N -th temperature T_N , respectively, and each of the first gray scale voltage sets comprises a plurality of gray scale voltages, and the controller outputs the second gray scale voltage set corresponding to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

5. The liquid crystal display according to claim 1, wherein the gray scale voltage generating units each comprise a variable resistor logic part used to generate the first gray scale voltage set.

6. The liquid crystal display according to claim 1, further comprising a data driving part generating a data voltage based on the second gray scale voltage set,

the controller outputting the second gray scale voltage set corresponding to the sensed temperature T to the data driving part.

7. A liquid crystal display comprising:

a liquid crystal panel;

a temperature sensor sensing a temperature T of the liquid crystal panel;

a gray scale voltage generating part comprising a plurality of gray scale voltage generating units each generating a gray scale voltage set corresponding to a preset temperature; and

a controller controlling the gray scale voltage generating part and selecting the gray scale voltage set corresponding to the preset temperature having a minimum difference from the sensed temperature T when the sensed temperature T does not correspond to the preset temperature.

8. The liquid crystal display according to claim 7, wherein the gray scale voltage generating units each comprise a variable resistor logic part used to generate a plurality of gray scale voltages.

9. The liquid crystal display according to claim 8, wherein the gray scale voltage generating part further comprises an N number of the gray scale voltage generating units corresponding to a temperature T_1 through a temperature T_N , and

the controller controls the gray scale voltage generating part and outputs the gray scale voltage set corresponding to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

10. The liquid crystal display according to claim 8,

wherein the gray scale voltage generating part further comprises an N number of the gray scale voltage generating units corresponding to a temperature T_1 through a temperature T_N , and

the controller controls the gray scale voltage generating part and outputs the gray scale voltage set corresponding to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

11. A control method of a liquid crystal display, the control method comprising:

generating first gray voltage sets corresponding to a first temperature T_1 through an N -th temperature T_N , respectively;

sensing a temperature T of the liquid crystal panel; and
generating a second gray scale voltage set corresponding to the sensed temperature T using the first gray scale voltage sets when the sensed temperature T is not between the first temperature T_1 , and the N -th temperature T_N .

12. The control method according to claim 11, wherein the generating first gray scale voltage set comprises generating a plurality of gray scale voltages, and

wherein the generating a second gray scale voltage set comprises when a temperature T_i is in a range between the first temperature T_1 and the N -th temperature T_N and the sensed temperature T satisfies $T_i < T < T_{i+1}$, calculating a k -th gray scale voltage $V(k, T)$ corresponding to the temperature T by the following equation:

$$V(k, T) = V(k, T_i) + \frac{V(k, T_{i+1}) - V(k, T_i)}{T_{i+1} - T_i} (T - T_i)$$

where $V(k, T_{i+1})$ is a k -th gray scale voltage corresponding to the temperature T_{i+1} and $V(k, T_i)$ is a k -th gray scale voltage corresponding to the temperature T_i .

13. The control method according to claim 11, wherein the second gray scale voltage set corresponds to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

14. The control method according to claim 11, wherein the gray scale voltage set corresponds to the N -th temperature T_N when the sensed temperature T satisfies $T > T_N$.

15. A control method of a liquid crystal display, the control method comprising:

generating gray voltage sets corresponding to a first temperature T_1 through an N -th temperature T_N , respectively;

sensing a temperature T of the liquid crystal panel; and
selecting the gray scale voltage set corresponding to a temperature between the first temperature T_1 and the N -th temperature T_N having a minimum difference from the sensed temperature T when the sensed temperature is higher than the first temperature T_1 or lower than the N -th temperature T_N .

16. The control method according to claim **15**, wherein the selected gray scale voltage set corresponds to the first temperature T_1 when the sensed temperature T satisfies $T < T_1$.

17. The control method according to claim **15**, wherein the selected gray scale voltage set corresponds to the N-th temperature T_N when the sensed temperature T satisfies $T > T_N$.

18. A liquid crystal display comprising:

a liquid crystal panel;

a temperature sensor sensing a temperature T of the liquid crystal panel;

a gray scale voltage generating part comprising a plurality of gray scale voltage generating units, each generating a gray scale voltage set corresponding to a preset temperature range; and

a controller controlling the gray scale voltage generating part and selecting the gray scale voltage set having the preset temperature range to which the sensed temperature corresponds.

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